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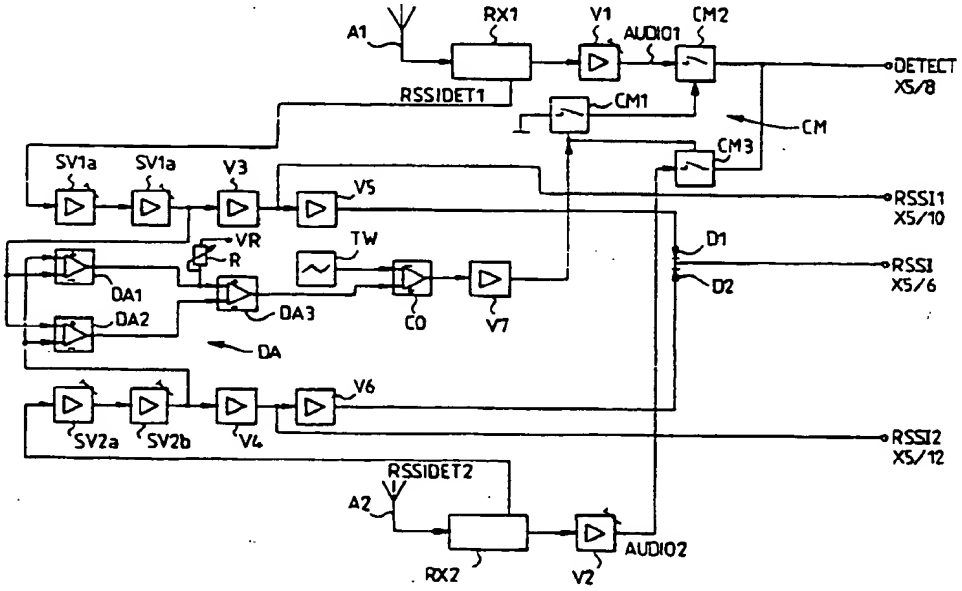
(54) Title: ANTENNA SWITCHING DIVERSITY RECEIVER



(57) Abstract

A diversity receiver comprising two receiver branches (RX1, RX2) with respective antennas (A1, A2), high- and intermediate-frequency parts, and means for generating signals (RSSIDET1, RSSIDET2) indicating the strength of signals received by the receiver branches; means (DA, TW, CO) for generating a control signal based on comparison between the signals (RSSIDET1, RSSIDET2) indicating the strength of the received signals; and switching means (CM) that switch a signal (AUDIO1, AUDIO2) from either one of the receiver branches (RX1, RX2) to a receiver output (DETECT), depending on the control signal. The means for generating the control signal comprise a differential amplifier connection (DA), a sawtooth generator (TW), and a comparator (CO).

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Antenna switching diversity receiver

Background of the Invention

Field of the Invention

This invention relates to a diversity receiver comprising two receiver branches with respective antennas, high- and intermediate-frequency parts, and means for generating signals indicating the strength of signals received by the receiver branches; means for generating a control signal based on comparison between the signals indicating the strength of the received signals; and switching means that switch a signal from either one of the receiver branches to a receiver output, depending on said control signal.

Prior solutions

The diversity receiver typically combines signals from different antennas by an intermediate-frequency constant-gain combination technique, where detection-frequency signals from the radio-frequency parts are phased with each other and summed. Phasing takes place by adjusting the frequency and phase of the output signal of the local oscillator of the second receiver branch. As the signals are summed coherently and noises non-coherently, the signal-to-noise ratio improves in the diversity receiver.

In the diversity receiver of the type described above, phasing of branches and interferences caused by the phasing are problematic. For these reasons, the sensitivities of individual receiver branches are relatively poor. In addition, the diversity gain is poor at higher fading rates.

EP Patent Applications 286 366 and 499 800 disclose diversity receivers of the type described in the preamble, where the better one of the signals of the branches is selected as an output instead of combining the signals.

Summary of the Invention

The object of the present invention is to provide a new diversity receiver, where the signals of different receiver branches are combined in a different way than previously. The object is thus a solution which is simpler and easier to tune than previous solutions and in which the sensitivities of individual branches and the fading properties are better. This is achieved by a diversity receiver according to the invention, which is characterized in that the means for generating a control signal based on comparison between the signals indicating the strength of the received signals comprise

a differential amplifier connection for generating a difference voltage of the signals indicating the strength of the signals received by the different receiver branches;

a sawtooth generator for generating a sawtooth wave signal; and

a comparator with two input terminals, said difference voltage being connected to one input terminal and said sawtooth wave signal to the other input terminal; and an output terminal for said control signal, which is a rectangular wave having a pulse ratio dependent on said difference voltage.

Brief Description of the Drawing

In the following the diversity receiver according to the invention will be described more fully with reference to the attached drawing, the figure of which shows a block diagram for an illustrating embodiment of the diversity receiver according to the invention.

Description of the Preferred Embodiment

The block diagram shown in the figure comprises two receiver branches RX1 and RX2, to which respective antennas A1 and A2 are attached. The receivers RX1 and RX2 contain conventional receiver parts, such as high- and intermediate-frequency parts as well as means for generating signals indicating the strength of signals received by the receivers. These signals, when they are outputted from the receiver branches RX1 and RX2, are indicated with the references RSSIDET1 and RSSIDET2. The actual, received signals are also outputted from the receiver branches RX1 and RX2; they are indicated after adjusting amplifiers V1 and V2 with the references AUDIO1 and AUDIO2.

The diversity receiver according to the invention utilizes the signals RSSIDET1 and RSSIDET2 obtained from the receiver branches and indicating the strength of the signals received by the branches for combining the signals received by the receivers, so that the signal obtained at the receiver output DETECT has a strength as high as possible. In the embodiment described, the signals RSSIDET1 and RSSIDET2 are first amplified by two adjusting amplifier stages indicated with the references SV1a, SV1b and SV2a, SV2b, respectively. After these adjusting amplifier stages,

the signals are applied to a further amplifier stage V3 and V4, respectively, after which output signals RSSI1 and RSSI2, respectively, are derived from the level of the signals received by the receiver branches for use in other connections. From the amplifiers V3 and V4, the signals are passed through still another amplifier stage V5 and V6 and a diode D1 and D2, respectively, to a third output RSSI, which represents the combined level of the signal strengths received by the receiver branches. The signal RSSI is not either essential to the present invention.

Instead, a procedure more essential to the invention is to generate the difference voltages of the output signals of the adjusting amplifier stages SV1b and SV2b. This is done by applying the output signals in question to comparators DA1 and DA2 so that the signals are both applied to both of the comparators though to their poles of opposite sign. In this way, the difference voltages of the output signals of the adjusting amplifier stages SV1b and SV2b produced at the outputs of the comparators DA1 and DA2 are of opposite sign. A dc voltage obtained from a dc voltage source VR through an adjusting resistor R is then added to the output signal of the comparator DA1. The output signals of the comparators DA1 and DA2, to the first-mentioned of which a dc voltage has been added as described above, are applied to a third comparator DA3, to its input poles of opposite sign. The signal from the output of the comparator DA1 is thus applied to the plus pole of the comparator DA3. The output of the differential amplifier DA3 thus gives the difference voltage of the signals indicating the strength of the signals received by the receiver branches RX1 and RX2. The level of the difference voltage has been adjusted by means a dc voltage signal

generated by the dc voltage source VR in such a way that it is midway between the operating voltages when a signal of equal level is received at both of the receiver branches RX1 and RX2. The differential amplifiers DA1, DA2 and DA3 form together a differential amplifier connection DA for generating the above-mentioned difference voltage. The difference voltage from the differential amplifier DA3 is applied to the plus pole of a comparator CO. A sawtooth signal of about 20 kHz is applied from a sawtooth generator TW to the other pole of the comparator CO. The frequency of this sawtooth signal is not critical in any way, but it should be above the audio band.

In the comparator CO, the sawtooth signal and the difference voltage of the signals indicating the strength of the signals received by the receiver branches are combined. A rectangular wave is thus produced at the output of the comparator CO, the pulse ratio of the wave depending on the magnitude of the difference voltage. The rectangular wave signal is first applied to an amplifier stage V7 and then it is used to control switching means CM, which connect either the signal AUDIO1 or the signal AUDIO2 to the output DETECT of the diversity receiver, depending on the pulse ratio of the signal. The audio signals of the receiver branches RX1 and RX2 thus act alternately in the receiver output DETECT, depending on the pulse ratio of the rectangular wave obtained from the amplifier V7.

In the embodiment shown in the figure, the switching means CM are implemented by three analogous switches CM1, CM2 and CM3. The rectangular wave from the output of the amplifier V7 is applied to the control input of both the analogous switch CM1 and the analogous switch CM3. The actual input of the

analogous switch CM1 is the grounding, the input of the analogous switch CM3 is the signal AUDIO2, and the input of the analogous switch CM2 is the signal AUDIO1. The output of the switch CM1 in turn is connected to the control input of the switch CM2. The purpose of the switch CM1 is thus to control the switch CM2 so that when the output of the amplifier V7 causes the switches CM1 and CM3 to close, the output of the switch CM1 causes the switch CM2 to open. In this way, either the signal AUDIO2 or the signal AUDIO1 only will be obtained in the output DETECT of the diversity receiver. This is because the outputs of the switches CM3 and CM2 are connected directly to the output DETECT.

In the diversity receiver according to the invention, the output signals of the different receiver branches are connected alternately to the output of the receiver, depending on the level of the signals received by the receivers. When the solution according to the invention is used, it is possible to avoid the problems associated with the phasing of branches on combining signals. The solution is thus simpler and easier to tune than previously. Moreover, the sensitivities of individual branches are maintained better and the fading properties are also superior to those of conventional diversity receivers.

The diversity receiver according to the invention has been described above by means of a single illustrating embodiment, and it is to be understood that it can be modified in various ways without deviating from the scope of protection defined in the attached claims. Accordingly, the described means both for generating a difference voltage and combining the signals of the receiver branches may deviate essentially from the switching example described

without any changes in the functions performed by them.

Claims:

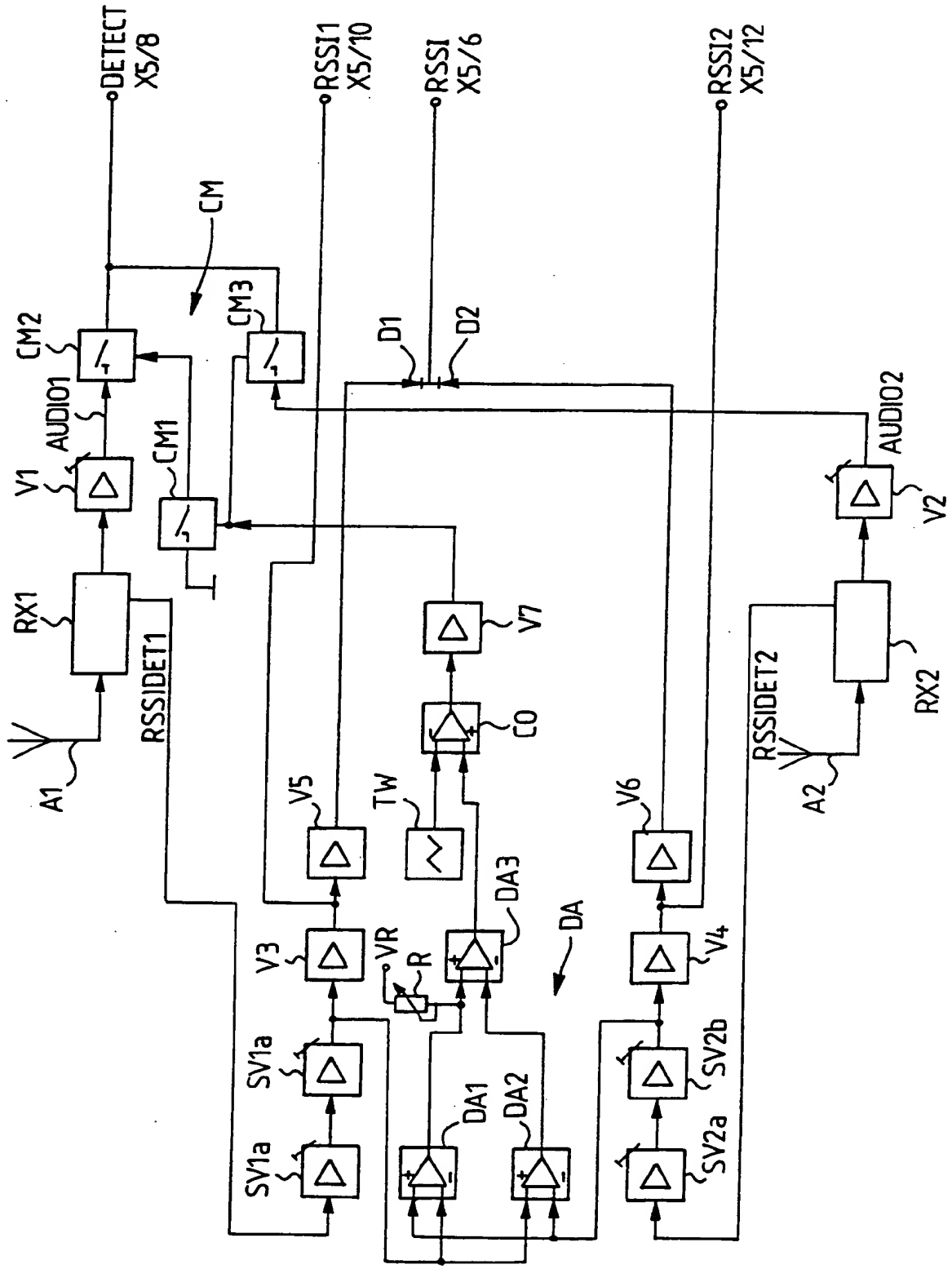
1. Diversity receiver comprising two receiver branches (RX1, RX2) with respective antennas (A1, A2), high- and intermediate-frequency parts, and means for generating signals (RSSIDET1, RSSIDET2) indicating the strength of signals received by the receiver branches; means (DA, TW, CO) for generating a control signal based on comparison between the signals (RSSIDET1, RSSIDET2) indicating the strength of the received signals; and switching means (CM) that switch a signal (AUDIO1, AUDIO2) from either one of the receiver branches (RX1, RX2) to a receiver output (DETECT), depending on said control signal, c h a r a c t e r i z e d in that the means for generating a control signal based on comparison between the signals (RSSIDET1, RSSIDET2) indicating the strength of the received signals comprise

a differential amplifier connection (DA) for generating a difference voltage of the signals indicating the strength of the signals received by the different receiver branches (RX1, RX2);

a sawtooth generator (TW) for generating a sawtooth wave signal; and

a comparator (CO) with two input terminals, said difference voltage being connected to one input terminal and said sawtooth wave signal to the other input terminal; and an output terminal for said control signal, which is a rectangular wave having a pulse ratio dependent on said difference voltage.

2. Diversity receiver according to claim 1, c h a r a c t e r i z e d in that the differential amplifier connection (DA) comprises a dc voltage source (VR) for summing a dc voltage to the difference voltage.


DETECT X5/8
RSSI1 X5/10
RSSI X5/6
RSSI2 X5/12
CM
CM2
CM3
D1
D2
AUDIO1
AUDIO2
V1
V2
CM1
RX1
RX2
RSSIDET1
RSSIDET2
A1
A2
V7
C0
V5
TW
V6
DA3
DA
V3
VR
R
V4
SV1a
SV1a
DA1
DA2
SV2b
SV2a

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 94/00472

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 7/08, H04B 1/16 // H04B 1/16
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US, A, 4823398 (KAZUYA HASHIMOTO), 18 April 1989 (18.04.89), column 3, line 14 - column 5, line 21, figures 3,4,5 --	1-2
A	US, A, 4742563 (YUKIO FUKUMURA), 3 May 1988 (03.05.88), column 1, line 54 - column 2, line 20, figure 1 --	1-2

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

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09/02/95

International application No.
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